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Long-term accelerometry tracks the swimming cost of ocean-migrating seals

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Efficient swimming is important for breath-hold divers that forage at depth, because they must optimize both the rate of energy gain and the rate of oxygen utilization. While experimental changes in buoyancy have been shown to affect swimming costs during diving, less is known about how natural changes in buoyancy affect foraging behaviour. We examined the effects of buoyancy changes on the swimming costs of female northern elephant seals (*Mirounga angustirostris*), which experience dramatic fluctuations in body condition and buoyancy during their months-long oceanic migrations. We recorded the number of flipper strokes with newly-developed accelerometer during the post-breeding (PB) and post-molt (PM) migrations (seven seals each). Negatively buoyant seals gradually became more buoyant as they foraged at sea, as assessed by changes in drift rates. The cost-of-transport (i.e. COT, assessed by the number of strokes m^{-1}) during dives decreased in the buoyancy-hindered direction (i.e. ascending; 0.446–0.277 (PB) and 0.370–0.118 (PM) strokes m^{-1}), but increased to a lesser extent in the buoyancy-aided direction (i.e. descending; 0.007–0.077 (PB) and 0.014–0.158 (PM) strokes m^{-1}) as seals became less negatively buoyant. Overall, the round-trip COT gradually decreased (0.462–0.324 (PB) and 0.408–0.236 (PM) strokes m^{-1}) and was lowest when neutral buoyancy was achieved (c. 0.26 strokes m^{-1}; neutral buoyancy was achieved by only three PM seals). At neutrally buoyant condition, the COTs during descent and ascent were equivalent. Seals spent more time at the bottom of the dives (i.e. foraging layer) when their round-trip COT was lower, possibly because they were able to use the oxygen saved from reduced locomotory costs during the transit to prolong their foraging time. These results suggest that buoyancy changes in the seals affect not only energy expenditure and oxygen utilization during locomotion but also energy gain via increased time spent in the foraging layer.